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ACCURACY OF KAPTON-EQUIVALENT ATOMIC OXYGEN FLUENCE IN A GROUND-BASED ATOMIC OXYGEN EXPERIMENTS

Abstract

Pyromelliticdianhydride oxydianiline, PMDA-ODA, Polyimide (commercially available as Kapton-H) has been used as a material for atomic oxygen (AO) fluence monitor both in low earth orbit (LEO) and in laboratories. The erosion rate of Kapton-H in the LEO was measured by the early Shuttle flight and the value of 3.0 x 10-24 cm3/atom was reported. This value has been used for measuring the AO fluence in many flight experiments. The value of 3.0 x 10-24 cm3/atom has been used in many ground-based studies as well as flight experiments without considering the difference in exposure conditions of AO. The difference in erosion rate in various exposure conditions has not been considered in most of the ground-based AO tests. In this study, erosion rate of PMDA-ODA polyimide was measured in various conditions in order to study the validity of "Kapton-equivalent AO fluence". The laser-detonation AO beam facility in Kobe University was used for simulating the reaction of AO and PMDA-ODA polyimide. The mass change of PMDA-ODA polyimide was detected by the quartz crystal microbalance during the AO exposure. The effects of sample temperature, angle of attack, synergistic effect with vacuum ultraviolet, collision energy and impurity in the beam on the PMDA-ODA polyimide erosion in the AO exposure experiments will be discussed in the talk. It was observed that the erosion rate of PMDA-ODA polyimide depends on the exposure conditions of AO beam. Therefore, it was concluded that the erosion rate of 3.0 x 10-24 cm3/atom for PMDA-ODA polyimide in the AO beam exposure was not applicable in the ground-based experiments, if certain exposure condition of AO beam in laboratory is different from that in LEO, i.e., the Kapton- equivalent atomic oxygen fluence is not accurate for a ground-based AO simulation in such conditions.